A Bioluminescence Bathyphotometer for an Autonomous Underwater Vehicle

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LONG-TERM GOALS

Our goal is to develop a compact bioluminescence detector system suitable for use on small AUVs for the purpose of mapping coastal bioluminescence.

OBJECTIVES

We plan to develop two identical bioluminescence bathyphotometers. One is to be evaluated for use on the REMUS AUV. The second is to be equipped with an independent support system permitting its use as a profiling and slow towing instrument for calibration of the AUV instrument package and for research in coastal waters related to the proposed naval end-use of the AUV bioluminescence detector and for environmental monitoring.

APPROACH

The most reliable method to measure bioluminescence potential of marine species involves mechanical excitation in an enclosed volume of seawater. Optimum design of a bioluminescence bathyphotometer must take into account the physiological properties of the luminescent organisms to be studied, specifically their mechanical excitability, excitation latency, flash duration and intensity (Case, *et al*.). When concerned with the complete gamut of species likely to be encountered in near surface waters — typically many species of dinoflagellates and a host of gelatinous zooplankters — large measuring systems are optimal since these permit rigorously defined excitation and dwelltime of the entrained specimens sufficient to measure most of the organism's flash (Widder, *et al*.). The available payload volume of the REMUS AUV for this application severely restricts the total available space for all components including the detection chamber to approximately 75% of a cylindrical volume 7 x 19 inches. Faced with this restriction, we developed a photometer system with a 500 ml excitation and measurement chamber with about at 0.3 sec dwelltime at an helical impeller induced flow rate of up to 2 l/sec. This is adequate for dinoflagellates, the organisms of principal interest, if biological calibrations with similar species are carried out on the final instrument.

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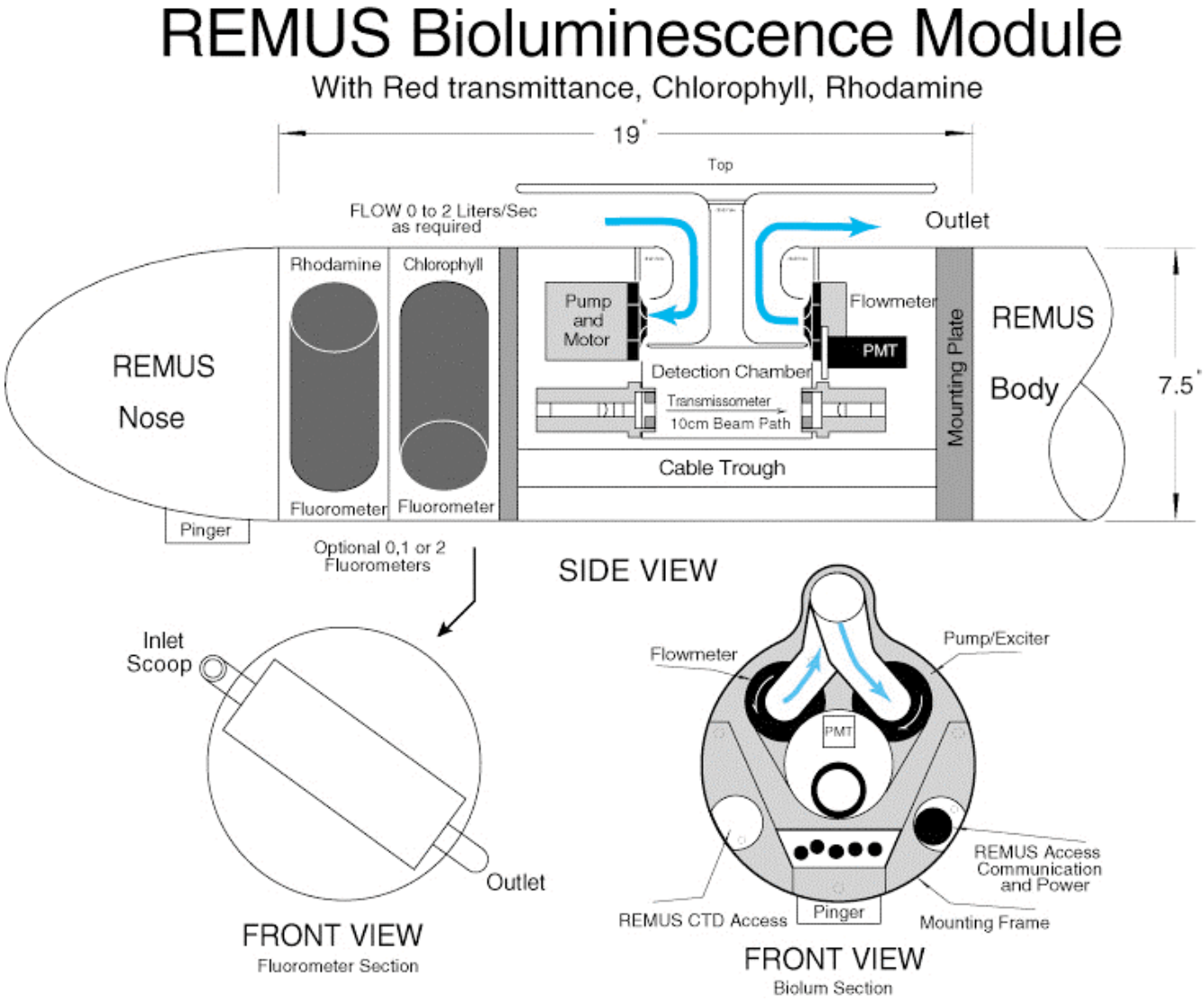

Figure 1

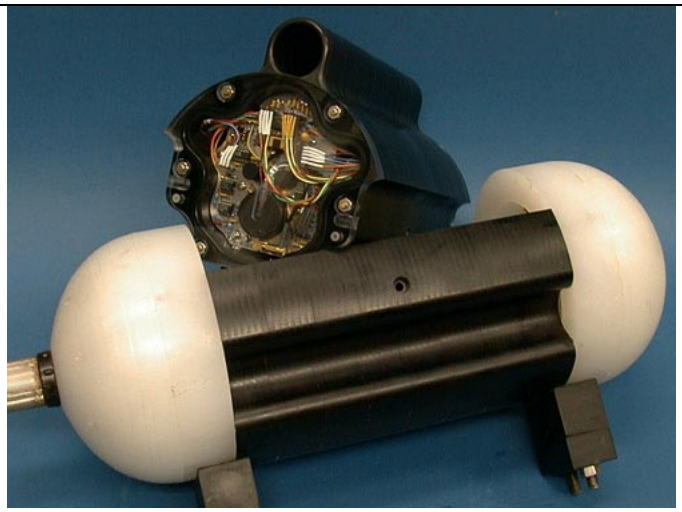

Figure 2.

WORK COMPLETED

Figure 1 is a conceptual drawing of the final design and Figure 2 shows the instrument configured for testing independently of REMUS at the Thin Layers 1998 test site in Puget Sound. Data plots from this deployment are found in the Alldredge, Case and McIntyre report in this volume. The instrument was built under the supervision of Cyril Johnson in the UCSB electronics and machine shops. To reduce cost and accommodate the complex ductwork to the available volume the basic structure was milled from approximately 1 in thick slabs of black polycarbonate. The detector is a Hamamatsu H5773 PMT. Water is pumped through the detector chamber by a light-blocking helical impeller and exit light-blocking and flow measurement is obtained with an identical impeller and magnetic sensor. Two fluorometers and a transmissometer are included in the system. Control/data software was developed by Steven Haddock.

RESULTS

The prototype was biologically calibrated with cultured luminescent dinoflagellates of known total stimulable light potential measured on aliquots stirred to luminescence extinction in the laboratory integrating sphere photometer. Equivalent samples were then run through the photometer. It was then field tested in the thin layers experiment and performed to specifications, easily tracking luminescence in vertical profiles in the strongly luminescent water at that site.

TRANSITIONS

Integration tests with the REMUS vehicle and a first sea trial are scheduled for early in 1999.

RELATED PROJECTS

A primary use of the detector system in AUV configuration will be for coastal bioluminescence monitoring for naval purposes with partial sponsorship from ONR Code 3220M. This use will be explored in collaboration with Dr. David Lapota. In addition, it is of interest to use the system as a possible monitor of early development of certain types of red tides characterized by significant luminescence.

REFERENCES

Case, J.F., et al. 1993. Assessment of Marine Bioluminescence. Nav. Res. Rev. 45:31-41.

Widder, E.A., et al. 1993. A New Large Volume Bathyphotometer With Defined Turbulence Excitation. Deep-sea Res. 40(3):607-627.